DOCUMENT RESUME

ED 273 447 SE 046 903

AUTHOR Good, Ron
TITLE Science Computer Software. A Handbook on Selection and Classroom Use.
INSTITUTION Florida State Univ., Tallahassee. Dept. of Science Education.
SPONS AGENCY Florida State Dept. of Education, Tallahassee.
PUB DATE Jul 86
NOTE 48p.
PUB TYPE Reference Materials - Directories/Catalogs (132)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Biology; *Chemistry; *Computer Assisted Instruction; Computer Simulation; Computer Software Reviews; *Courseware; Educational Technology; Elementary School Science; Instructional Materials; *Physics; Resource Materials; Science Education; *Science Instruction; Secondary Education

ABSTRACT

Designed for use by science teachers, this document provides selected lists of computer software collected by the Science and Mathematics Software (SAMS) lab at Florida State University. The commercially available software is compiled under the subject areas of biology, chemistry, and physics. Each list provides: (1) recommended grade level; (2) type of software (e.g. drill and practice, tutorial, simulation, game, tool); (3) publisher; and (4) price. Included are reviews done by the SAMS lab on selected software from each discipline. Twelve software programs are reviewed in the biology section, ten in chemistry, and eight in physics. The chapter on chemistry also mentions additional software available through the National Science Foundation-funded project SERAPHIM at Eastern Michigan University. Addresses of publishers/distributors of all the commercial software listed are also included. (TW)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED273447

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
✓ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

SCIENCE COMPUTER SOFTWARE

A Handbook on Selection and Classroom Use

Prepared by the Science and Mathematics Software (SAMS) Lab at Florida State University, July 1986

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
R. Good
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SE 046 903

PREFACE

This handbook is designed for science teachers who understand that computers can help students learn science in new and exciting ways. Among the thousands of computer programs available, some are of high quality and reasonably priced while many others offer neither of these features. You have probably received many catalogs from publishers of science instructional software, all of them suggesting that their products are of high quality. To purchase and preview this software requires much more time and money than is available to most science teachers. This handbook should help you in both areas.

The Science and Mathematics Software (SAMS) Lab is a Florida Department of Education project that previews and evaluates instructional software, conducts workshops for teachers, and generally provides assistance to schools trying to upgrade their use of instructional software in science and mathematics classes. Currently housed at Florida State University, the SAMS Lab has over 500 pieces of computer software for use in science and mathematics teaching. One of the basic principles followed by the SAMS Lab is - select and use computer software that allows students to experience new ways of learning. Programs that teach by presenting pages of text do little that cannot be done by a textbook or a worksheet.

This handbook presents commonly accepted criteria for use in evaluating instructional software. The criteria are used to select examples of software, particularly simulations and "tools", that allow students to experience new ways of learning. The absence of a particular piece of software form the physics section, for instance, does not necessarily mean it is of low quality. Due to the large number of pieces of software available and the limited space in this handbook, it is not possible to include descriptions and possible uses of all software. Further, although the SAMS Lab is funded by the Florida DOE, the views expressed in this handbook do not necessarily reflect the position of that agency.

Among the persons contributing to material found in this handbook are S. Berenson, M. Eason, K. Ellington, J. Evans, S. Henrich, D. Lavoie (Assistant Director), and S. Schleuter. Many thanks to Annette Weglinski for her typing skills and other fine assistance to the SAMS Lab. We hope you find this handbook helpful and that your students better understand and enjoy science as a result.

Ron Good, SAMS Lab Director and
Professor of Science Education
Florida State University

CONTENTS

Preface i

Selecting Science Software 1

Biology Software 5

Chemistry Software 16

Physics Software 28

Other Software 38

Software Publishers/Distributors. 41

Final Thoughts 44

SELECTING SCIENCE SOFTWARE

Many groups, including the National Science Teachers Association, have published criteria for use in selecting science instructional computer software. Obviously, the reasons or goals one has for using the computer software will influence the selection process. The SAMS Lab has emphasized the use of simulations and tools (e.g., function plotters, automatic lab data handlers, vector packages) that allow students to learn science in ways not possible without these marvelous number crunchers. In his widely-read book, Mindstorms, Seymour Papert talks of "microworlds" as computer environments that allow students to control systems in order to learn more about causes and effects. The Dynaturtle, controlled by the computer user, provides a means to understand in very concrete terms what Newtonian motion is like.

Goals for science teaching and learning have an important effect on the selection of computer software. With this in mind, we now provide criteria the SAMS Lab has found to be useful in selecting and evaluating science software.

Types of Software and Criteria

For our purposes here, we will use 5 categories to describe science software: tutorials, drill and practice, simulations, games, and tools. We will not consider the many examples of word processing, class management, spreadsheets, databases, graphics packages, program languages and other categories of available software.

For each of the 5 types of software, we should ask questions about A) the instructional content and applications and B) technical quality.

A. Instructional Content/Applications

1. Is the content accurate?
   Incorrect content, whether in textbooks or computer programs, is unacceptable. It is true that our knowledge about nature is subject to change, but we should use the most accurate facts and ideas available in our instructional materials.

2. Is the content relevant?
   This question can be answered well only by the science teacher who intends to use the software.

3. Is the content of interest to students?
   The best way to learn of students' interest in and involvement with the software is to use it in the classroom. Short of this, experience with students and computer software are necessary.

4. Does the content provide for different ability levels?
   Except for rote learning of terms, etc. this is an important factor. For programs that provide problem-solving practice, various levels of difficulty should be provided.

5. Is the student actively engaged or passive?
A high degree of interaction takes advantage of the computer as patient and (hopefully) intelligent tutor. If the student is expected to input numeric values for an upcoming dynamic simulation or to solve sample problems, active involvement and learning are much more likely to result.

6. Is self-testing built in?
A student should be able to monitor her/his progress. Questions and problems with feedback can provide the necessary feedback. Of course, with some software, especially simulations and games, progress is evident to the user. Some software packages offer feedback to the teacher as well as the student.

7. Are inquiry processes integrated into the software?
Since the nature of science as inquiry/process is well established, this should be reflected in most software.

8. Is important lab work replaced?
The computer should not be used as an excuse to reduce lab work that provides students with a concrete sense of exploration, measurement, and the excitement of discovery. As extraordinary number cruncher, a computer can extend and supplement regular lab work. Lab interface devices can be very helpful tools, as can other specialized programs (tools) designed for data analysis and representation.

9. Is the content free from stereotyping?
It is important that all students be encouraged to develop free, inquiring minds.

B. Technical Quality

1. Are the graphics of high quality?
Where graphics are used, they should be of high quality. After viewing a dozen or so software packages, the meaning of quality will likely become clearer. In simulations and games, dynamic graphics are of utmost importance.

2. Are the graphics used intelligently?
Having a nice replica of a dinosaur on the viewing screen does not mean the graphics are used intelligently. Instructional software should take advantage of the unique capabilities of the computer. If the viewing screen simply replicates a page of a textbook why use the computer? Dynamic graphics do what the textbook cannot and usually offer the user a high degree of control over the system being simulated on the screen. Representing and rotating chemical molecules as three-dimensional figures cannot be done with textbooks (see Modeler in the Chemistry section).

3. Is the program "user-friendly"?
Can the student easily learn how to use the software or must many commands be mastered first? Once into the instructional sequence (e.g., level of a game or step in a problem) can the user easily move to another part of the program?

4. Are documentation and other guidance materials comprehensive and well-designed?
With some software, documentation is not particularly important. A good tutorial, for example, might need little accompanying documentation. A simulated harmonic motion system, however, should have background information and, if the program is not list protected (a very desirable feature), some information should be included on the internal operation of the program. Vernier, publisher of physics software, does an excellent job of providing documentation that allows students to learn physics and computer programming.

5. Are there long delays?
Especially for tutorials and drill and practice software, the pace of the program is important.

6. Can sound be controlled?
Where sound is an important part of the instruction, there should be a way to control the volume. In tutorials, students should have control over sounds indicating correct/incorrect answers. In games, the teacher should be able to reduce or eliminate unwanted sounds.

Other Important Questions

There are many other questions that might be asked about instructional software for science. The 1983 version of the instrument developed by the National Science Teachers Association has 32 criteria for software evaluation. Certainly one important question that must be asked is, Is the software worth the money? The range of the cost of commercially available software is about $25 to $100. Poor-quality software at any price should be avoided. High-quality software can be found throughout the $25 to $100 range and beyond. One very important factor to consider is copy-protection. Can you make copies for your students when they need to use the materials simultaneously? High-quality software that can be copied (legally) with good documentation at a modest price is not found in abundance, but there are some examples as you will see later in this handbook. Vernier (physics software) is a particularly good example since it also allows the student or teacher to list the program code that controls the on-screen program. This provides many opportunities for learning that would otherwise be unavailable. The SAMS Lab highly recommends high quality software that is not list-protected.

IDEAL SOFTWARE: The profile of an evaluation for an ideal software package might look like this --

Instructional Value:	High
Interest to Students:	High
Technical Quality:	High
Cost:	Low
Copy-Protection:	None
List-Protection:	None
Documentation:	Extensive

Even if cost were rated as high ($75-$100), a software package with this profile would be a good buy. Most publishers offer a back-up disk for about $10 (sometimes free) and a replacement disk for about $10 if the original is returned.

BIOLOGY SOFTWARE

At the 1986 Florida Instructional Computing Conference in Orlando, a paper, "The Use of Computer Simulations in Biology Teaching" was presented by D. Lavoie and R. Good. This section draws heavily from that paper and from SAMS Lab reviewers who have classroom tested much of the computer software.

What is Available?

The most comprehensive listing of instructional software is the 1986-87 edition of The Educational Software Selector (TESS), EPIE Institute and Teachers College press. Entries for biology software (213) are a bit less than for chemistry (237) and physics (249) but nonetheless represent a considerable range of choices for the biology teacher. The SAMS Lab has over 75 listings of biology programs, the majority being simulations. Most are intended for use with high school students, but some can also be used with middle school students and college students. Much of the information on cost, grade level, type of software, etc. is derived from The Education Software Selector (TESS). An inspection of Table 1 shows that about 43% of the listings fall within the $25-$49 range, 50% in the $50-$74 range, and the remainder are above $75 (7%). One entry, "Gene Structure and Function", includes 4 disks in the package so the $195 cost is misleading. "Cardiovascular Fitness Lab" ($165), "Experiments in Human Physiology" ($249), and "Experiments in Science" ($249) are lab-interface packages. A lab-interface package includes equipment that plugs into the computer and probes that collect data. It is a "tool" that can be used for demonstrations and during labs. Their main value is in the automatic data collection and display capabilities. An excellent general-purpose interface package at a very reasonable price ($60) is the "Science Toolkit" by Broderbund. The "Science Toolkit" allows the user to record temperature and light intensity by using probes that connect to an interface box which, in turn, plugs into the joystick port. Data are collected for up to 24 hours and displayed as either a simulated thermometer (or lightmeter) or as a moving strip chart. All data can be saved and printed as desired. The "Science Toolkit" may well be the best, reasonably-priced lab interface package currently available. The SAMS Lab rating for Broderbund's "Science Toolkit" is EXCELLENT.

TABLE 1

BIOLOGY SOFTWARE AT THE SAMS LAB

TITLE	SUBJECT	GRADE	TYPE	PUBLISHER	PRICE
ADVANCED GENETICS	BIO	10-16	TUT, SIM	EME	62.00
ALLOMETRY	BIO	10-16	TUT, SIM	COMP	60.00
ANIMAL REPRODUCTION	BIO	9-13	TUT	J&S	28.00
ASEXUAL REPRODUCTION	BIO	9-13	TUT	J&S	28.00
AVI CULTURIST II	BIO	10-16	TOOL	CDL	60.00
BALANCE	BIO	8-14	SKS, SIM	DEE	55.00
BIRDBREED	BIO	11-16	SIM	EDUTEC	95.00
CARDIOVAS. FIT. LAB	BIO	9-16	SIM, CMP	HRM	165.00
CELLS	BIO	6-10	SKS, TUT	EAC	49.95
CELLS	BIO	9-13	TUT	J&S	28.00
CELLULAR REPRODUCTION	BIO	6-10	TUT	MERLIN	45.00
CLASSIFICATION	BIO	9-13	TUT	J&S	28.00
CLASSIFY	BIO	8-14	SKS, SIM	DEE	55.50
COEXIST	BIO	9-16	SKS, SIM	CON	45.00
COMPETE: PLANT COMPE	BIO	9-16	SKS, SIM	CON	45.00
DICROSS	BIO	9-15	SKS, SIM	DEE	50.00
DIET	BIO	5-12	SIM	COMPUW	25.00
DILUTE	BIO	9-14	SKS, SIM	DEE	55.00
DNA I & II (2)	BIO	9-15	TUT, SIM	EME	93.00
DNAGEN	BIO	9-15	SKS, SIM	DEE	50.00
ECOLOGICAL MODELING	BIO	9-15	TUT, SIM	CON	75.00
ENDOCRINE	BIO	9-13	TUT	J&S	28.00
ENZYME	BIO	9-15	SKS, SIM	DEE	55.00
EVOLUT	BIO	9-15	TUT, SIM	CON	45.00
EXCRETION	BIO	9-13	TUT	J&S	28.00
EXP. IN HUMAN PHYSIO	BIO	9-15	CMP. TOOL	HRM	249.00
EXPERIMENTS IN SCIEN	BIO	6-12	CMP. TOOL	HRM	249.00
FLYGEN	BIO	9-15	SKS, SIM	DEE	50.00
GENE STR. & FUNC. (4)	BIO	9-15	TUT, SIM	EDUTEC	195.00
GENETICS	BIO	9-13	TUT	J&S	28.00
GENETICS	BIO	11-16	DRL, TUT	CDL	50.00
GENETICS & EVOLUTION	BIO	9-15	TUT, SIM	EME	79.00
HEART LAB	BIO	7-13	SIM	EAC	50.00
HEREDITY DOG	BIO	9-14	TUT	HRM	59.00
HUMAN BODY (THE)	BIO	9-10	TUT	BBX	90.00
INTERACTIONS	BIO	9-14	SIM	COMP	60.00
LIFE	BIO	9-14	GAME	COMP	60.00
LIFE TABLES/LESLIE	BIO	13-16	TUT, SIM	CON	50.00
LIMITS	BIO	10-14	SIM	COMPUW	24.95
LINKOVER: GENET. MAP	BIO	9-15	SIM	CONDUI	45.00
LOCOMOTION	BIO	9-13	TUT	J&S	28.00
MALARIA	BIO	8-14	SIM	COMPUW	25.00
MANGRY	BIO	9-15	SKS, SIM	DEE	60.00
MARK AND RECAPTURE	BIO	9-14	SIM	CON	50.00
MENDELIAN GENETICS	BIO	8-14	TUT, SIM	COMP	70.00
MICRO TECHN	BIO	9-16	TUT, SIM	EME	45.00
MONOCROSS	BIO	9-14	SKS, SIM	DEE	50.00

TABLE 1 (continued)

TITLE	SUBJECT	GRADE	TYPE	PUBLISHER	PRICE
NERVOUS SYSTEM	BIO	9-13	TUT	J&S	28.00
NICHE	BIO	7-14	SKS, SIM	DEE	50.00
OH DEER	BIO	5-9	SIM	MECC	49.00
OPERATION FROG	BIO	8-12	SIM, TUT	SCHOLA	60.00
OSMOTIC PRESSURE	BIO	9-12	SIM	SUMIT	60.00
OSMOTIC PRESSURE	BIO	10-14	SKS, SIM	CON	50.00
PHOTOSYNTHESIS	BIO	9-13	TUT	J&S	28.00
PHYSIOLOGICAL SIM.	BIO	9-15	SIM	SCOTT	59.95
PLANT	BIO	8-14	SKS, SIM	DEE	70.00
POLLUTE	BIO	8-13	SIM	COMPUW	25.00
POP GROWTH	BIO	9-16	SIM	CON	50.00
POPGROW	BIO	9-14	SKS, SIM	DEE	50.00
POPULATION GROWTH	BIO	9-15	SIM	COMP	70.00
PREDATION	BIO	11-16	TUT, SIM	CON	50.00
PROFILES IN POP.	BIO	11-16	SIM	COMP	50.00
PROTOZOA	BIO	7-14	TUT, GAM	VENTUR	39.95
RATS	BIO	7-13	SIM	COMPUW	25.00
REPROD. PLANTS	BIO	9-13	TUT	J&S	28.00
RESPIRATION	BIO	9-13	TUT	J&S	28.00
SCIENCE TOOL KIT	BIO	6+	CMPT	BRODER	60.00
SENSES	BIO	8-12	GAME	VENTUR	40.00
SKELETAL SYSTEM	BIO	4-10	TUT	BB	70.00
SOLAR FOOD	BIO	10-16	TUT, GAM	HRM	70.00
TEMPERATURE GRAPH	BIO	9-16	CMP. TOOL	HRM	79.00
USPOP	BIO	11-14	SIM	COMPUW	24.95
WATER POLLUTION	BIO	7-14	TUT, SIM	EME	29.50
YOUR BODY SERIES I	BIO	6-10	GAME, TUT	FOCUS	119.00
YOUR BODY SERIES II	BIO	6-10	GAME, TUT	FOCUS	119.00

Evaluations of Selected Software

The most important part of this SAMS Lab Handbook is the evaluation of selected software. It is here that software is evaluated, with comments for the classroom teacher. Most of the biology software selected for review consists of simulations of genetics crosses, plant and animal competition, population growth, genetics and evolution, pollution, and related dynamic systems that usually require complicated calculations and/or long-term data collection, often outside the school environment. Because of limited space, some good software is not reviewed.

Each review of the software follows a similar format: Title, Publisher, Cost, Computer Required, Grade levels, Instructional Content, Technical Quality. This information is followed by a SAMS Lab "profile" listing instructional value, interest to students, technical quality, cost, copy-protection, list-protection, and documentation. The listing is alphabetical.

Program 1

Title: Advanced Genetics
Publisher: Educational Materials & Equipment (EME)
Cost: $77.00 (includes backup disk)
Computer Required: Apple II/II+/IIe
Grade Levels: 10-16

Instructional Content:
Complete coverage of all types of dominance, lethality, multiallelic traits, linkage (sex and autosomal), crossing over, mapping. User may design experiments using one or more concepts. Paper and pencil are required for notes and experiments can get involved. Teaches scientific method as well as genetics.

Technical Quality: Good

SAMS Lab Profile:
Instructional Value . . . . . HIGH
Interest to Students. . . . . HIGH (for capable students)
Technical Quality . . . . . GOOD
Cost. . . . . HIGH
Copy Protection . . . . . YES (network version available)
List Protection . . . . . YES
Documentation . . . . . EXTENSIVE

Program 2

Title: Balance: Predator-Prey
Publisher: Diversified Educational Enterprises (DEE)
Cost: $70.00
Computer Required: Apple II+/IIe/IIc; TRS 80; IBM PC/Jr
Grade Levels: 8-14

Instructional Content:
Program allows manipulation of five variables to investigate predator-prey relationships: deer population, wolf population, type of environment (forest, meadow, grassland), deer killed other than by wolves, and number of wolves killed by humans. Tabular and graphic output illustrate effects of variables on the related population.

Technical Quality: Generally good but slow in plotting graphs.

SAMS Lab Profile:
Instructional Value . . . . . ABOVE AVERAGE
Interest to Students. . . . . HIGH
Technical Quality . . . . . GOOD
Cost . . . . . ABOVE AVERAGE
Copy Protection . . . . . NONE
List Protection . . . . . NONE
Documentation . . . . . GOOD

Program 3

Title: Birdbreed
Publisher: EduTech
Cost: $110.00 (includes backup disk)
Computer Required: Apple II+/IIe
Grade Levels: 10-15

Instructional Content:

This program provides a detailed and comprehensive simulation of inheritance patterns involving one or two traits. The principle of probabilities in genetics, especially with small clutch sizes, is clearly demonstrated. Four levels of difficulty make the student familiar with single gene dominance, incomplete dominance, sex-linkage, multiple alleles, linkage with cis or trans arrangements.

Technical Quality: Good

SAMS Lab Profile:

Instructional Value . . . . . HIGH
Interest to Students. . . . . ABOVE AVERAGE
Technical Quality . . . . . GOOD
Cost. . . . . HIGH
Copy Protection . . . . . YES
List Protection . . . . . YES
Documentation . . . . . NONE

Program 4

Title: Cardiovascular Fitness Lab
Publisher: Human Relations Media (HRM)
Cost: $165.00
Computer Required: Apple II+/IIe; Commodore 64
Grade Levels: 9-16

Instructional Content:

This package includes a pulse sensor that clips to the earlobe or finger, an interface card, the software disk, and a guide. Data on heart rate (up to 2 hours) can be plotted, as a line graph or as a histogram. Also, the screen can display current heart rate and elapsed time. The SAMS Lab staff has found the pulse sensor to be difficult to use for consistent results. When working properly, students show a high degree of interest in experimenting with it.

Technical Quality: Very good (when the sensor works properly)

SAMS Lab Profile:

Instructional Value . . . . . HIGH
Interest to Students. . . . . HIGH
Technical Quality . . . . . VERY GOOD (when sensor works properly)
Cost. . . . . HIGH
Copy Protection . . . . . YES
List Protection . . . . . YES
Documentation . . . . . BRIEF

Program 5

Title: Compete: Plant Competition
Publisher: Conduit
Cost: $40.00
Computer Required: Apple II+/IIe/IIc; TRS 80; PET
Grade Levels: 9-16

Instructional Content:

Intra- and inter-species competition in commercial plant communities are simulated. The four plant species, barley, oats, tall peas, and short peas are grown in rows with variable spacing. They can be grown in monoculture to demonstrate density effects or in a mixture of two at a time so intra- as well as inter-competition are shown. For every growth experiment the total dry mass per square meter of both species is plotted against the time of planting. This program could be used to supplement a unit on ecology to demonstrate the effects of competition and the application of modeling.

Technical Quality: Good, especially the graphics

SAMS Lab Profile:

Instructional Value . . . . . HIGH
Interest to Students. . . . . ABOVE AVERAGE
Technical Quality . . . . . GOOD
Cost. . . . . MODERATE
Copy Protection . . . . . YES
List Protection . . . . . NO
Documentation . . . . . BRIEF

Program 6

Title: Genetics and Evolution
Publisher: Educational Materials and Equipment (EME)
Cost: $97.00 (includes backup)
Computer Required: Apple II/II+/IIe
Grade Levels: 9-15

Instructional Content:

Simulations are performed based on the Hardy-Weinberg Principle (with optional migration, mutation selections), genetic drift, palingenesis, and allometry. The user manipulates variables and compares graphs. To demonstrate genetic drift up to 16 different species are displayed and frequencies are shown in a histogram. The results are slow when more than 10 species are used. This program deals with rather advanced concepts and assumes the user understands the basics of these concepts.

Technical Quality: Good, but a bit slow in places

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	GOOD (for advanced students)
Technical Quality	GOOD
Cost	HIGH
Copy Protection	YES (network version available)
List Protection	YES
Documentation	VERY BRIEF

Program 7

Title: Heredity Dog
Publisher: Human Relations Media (HRM)
Cost: $49.00 (includes backup)
Computer Required: Apple II/II+/IIe
Grade Levels: 9-14

Instructional Content:

Important terms are defined at the beginning with an optional quiz. The simulations involve one or two gene systems with uncomplicated inheritance patterns. Parents with known genotypes and litter size are selected and additional litters from the same parents are possible. All genes are autosomal, unlinked, and color coded for easy identification. Data collection during simulations can be recorded on worksheets provided.

Technical Quality: Good

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH
Technical Quality	GOOD
Cost	MODERATE
Copy Protection	YES
List Protection	YES
Documentation	GOOD

Program 8

Title: Linkover-Genetic Mapping
Publisher: Conduit
Cost: $40.00
Computer Required: Apple II+/IIe/IIc; TRS 80; PET
Grade Levels: 9-15

Instructional Content:

After some instruction in basic Mendelian genetics, students would benefit from using this program. The user specifies a series of crosses and from the results, builds a map for linkages using the three-point testcross method. Problem-solving ability is stressed by solving the genetic maps provided. Some calculations take time, resulting in pauses during execution of the program.

Technical Quality: Fairly good, with some long pauses during calculations

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH (for capable students)
Technical Quality	FAIRLY GOOD
Cost	MODERATE
Copy Protection	YES
List Protection	NO
Documentation	GOOD

Program 9

Title: Mangry-Humans, Energy & Environment
Publisher: Diversified Educational Enterprises (DEE)
Cost: $60.00
Computer Required: Apple II+/IIe/IIc; TRS 80; IBM PC/Jr
Grade Levels: 9-16

Instructional Content:

In a mythical land called Ecos, the user experiments with human-environment interactions. With four basic ecosystems, agricultural, desert, forest, and grassland, the user selects the area of each system and sets initial population size, growth rate, and time interval. The simulation then shows productivity, number of humans, energy usage, and environmental input. The simulations may be done with different human cultures: hunter-gatherer, early and advanced agricultural, early and advanced industrial. Large numbers are expressed in scientific notation.

Technical Quality: Good, but without color graphics

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH
Technical Quality	GOOD
Cost	MODERATE
Copy Protection	NO
List Protection	NO
Documentation	GOOD

Program 10

Title: Popgro - Population Growth Simulations
Publisher: Diversified Educational Enterprises (DEE)
Cost: $60.00
Computer Required: Apple II+/IIe/IIc; TRS 80; IBM PC/Jr
Grade Levels: 9-14

Instructional Content:

Three different models of population growth are presented: 1) the logistic curve without density dependence, 2) a sigmoid curve resulting from addition

of a carrying capacity, and 3) time logs. The user selects initial population size, growth rate and duration of simulation. The simulation results can be output in the form of a data table, regular graph, or semilog graph. All three models can be selected side-by-side so comparisons are simplified. As with most simulations of this type, individual students or groups can use the program as a tool to explore the effects of certain variables on systems of interest.

Technical Quality: Good speed and interactive capabilities

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH
Technical Quality	GOOD
Cost	MODERATE
Copy Protection	NO
List Protection	NO
Documentation	GOOD

Program 11

Title: Predation
Publisher: Conduit
Cost: $50.00
Computer Required: Apple II+/IIe/IIc
Grade Levels: 11-16

Instructional Content:

The general behavior of predator-prey models is clearly illustrated in this software. The Lotka-Volterra model is illustrated in some detail, showing in graphic form the cyclic relationship over time between predator and prey. Positive, negative, and zero growth rates are explained. After the initial tutorial, the user can select other advanced predation models (Leslie-Gower, Holling-Tanner) and vary each parameter in the model to see how the resulting graphs are affected. Mathematical descriptions of the models are shown, but this is not a major part of the program. For the serious student who wants to better understand population dynamics, Predation should be very helpful.

Technical Quality: Very good

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH (for serious students)
Technical Quality	VERY GOOD
Cost	MODERATE
Copy Protection	YES
List Protection	NO
Documentation	BRIEF

Program 12

Title: Water Pollution
Publisher: Educational Materials and Equipment (EME)
Cost: $30.00
Computer Required: Apple II/II+/IIe; TRS 80
Grade Levels: 7-14

Instructional Content:

This program allows the user to manipulate five variables (body of water, temperature, dumping rate, type of treatment, and type of waste) that affect the concentration of oxygen and waste in water over time. Oxygen and waste curves are simultaneously plotted in color on the same graph after the necessary background information has been presented. Research by D. Lavoie suggests that this software can be used to encourage students to practice the process of prediction. Groups of students could be formed to investigate certain environments, followed by discussions, rechecking results, etc.

Technical Quality: Good, with nice graphs at an effective pace.

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH
Technical Quality	GOOD
Cost	LOW
Copy Protection	YES
List Protection	YES
Documentation	GOOD

Other Biology Software and Ideas for Teaching

Eleven of the twelve software packages just reviewed allow the user to control factors (variables) related to dynamic systems. By exploring the systems in this way, students learn in more meaningful ways about important science concepts that otherwise would likely be memorized with little understanding. Other computer software listed in Table 1 and in the science section of The Educational Software Selector (TESS) by EPIE Institute and Teachers College Press can be effectively used in biology teaching. The Heart Lab, published by Educational Activities, has received positive reviews by a number of groups that review educational software. A tutorial shows a beating heart and students learn about the chambers of the heart and blood flow. Following this, students can input heart rates after exercise and the program outputs a simulation of this recovery rate, including the amount of blood pumped. This program is a simple simulation that can be done easily without a computer, however. Since it is intended for students in grades 5-12, some teachers in grades 5-8 might find it useful as a supplement to texts, films, etc.

There are many other examples of computer software that "simulate" anatomy/physiology systems. Some are static figures and others depict movement. All can be better illustrated with real labs, good films, and even pictures and diagrams in books. Using the computer as a "talking" textbook fails to take advantage of the unique power of computers. Complex simulations as in genetics

and ecological modeling do take advantage of the computer's real power. As a computational tool, the computer is a very powerful instructional aid that is unequaled by textbooks and other conventional media.

Lab interface devices offer considerable potential for assisting in data collection, analysis, and interpretation. Experiments in Human Physiology by HRM has received many positive reviews. For $200, this lab interface device can be purchased and used (Apple only) to collect, analyze, and display data about various physiological experiments. Usually with much less expensive equipment, however, students can do the same experiments. The teacher must decide whether the convenience offered by interface devices such as this justify the outlay of funds. Because of the introduction of Broderbund's, Science Toolkit for only $60, the SAMS Lab predicts that interface packages will drop in price and become more widely used in science classes in grades 5-12.

Other computer software offer skills practice and reviews of concepts, and terms normally covered in biology. Some programs keep records of students' responses while others help the user create tests. For the biology teacher who enjoys programming, there are picture files and authoring languages that make it easier to develop lessons for students.

To end this section on biology software, the SAMS Lab again emphasizes the importance of using the computer in the classroom as a way of helping students learn in ways that otherwise would be unavailable. Simulations of complex systems with the student in control allow learning through inquiry and exploration (doing science).

CHEMISTRY SOFTWARE

In addition to the 230+ entries for chemistry in the 1986-87 Educational Software Selector, there is an NSF-funded project (SERAPHIM) that adds another 60+ disks for chemistry education. Because Project SERAPHIM is a nonprofit effort, the disks are only $5 each and they may be copied for class use as necessary. The SAMS Lab at Florida State University is a distribution center for Project SERAPHIM which means that all materials are available to schools for inspection and copying. Of course, the materials can be purchased from SERAPHIM headquarters at Eastern Michigan University (Chemistry Department), Ypsilanti, MI 48197.

This section on Chemistry Software describes the SERAPHIM software that might be applicable to high school chemistry and then presents evaluations of selected commercially available software. As with the biology software that was described and evaluated, emphasis in chemistry is placed on software that helps students learn in ways that are not likely with books and other conventional instructional media.

Project SERAPHIM

The January 1986 catalogue for Project SERAPHIM identifies 60+ disks formatted for the Apple II/II+/IIe series, containing 175 separate programs. About half of these programs are written at a level appropriate for high school students while the others are a mixture of specialized tools for college chemistry teachers and advanced students. Many programs are formatted for Atari, PET/C-64, IBM PC/PC Jr, Macintosh, and TRS 80. The 14 categories or levels of software are: (1) high school chemistry, (2) general college chemistry, (3) organic chemistry, (4) analytical chemistry, (5) inorganic chemistry, (6) physical chemistry, (7) biochemistry, (8) environmental chemistry, (9) polymer chemistry, (10) industrial chemistry, (11) remedial mathematics, (12) numerical methods, (13) statistical analysis, and (14) other (specified).

Some of the programs that seem to be appropriate for high school chemistry students are briefly described. A free catalog is available from Project SERAPHIM headquarters. Twelve series of programs are structured as follows:

Series 100	Methods of Chemistry	7 disks	20 programs
Series 200	Atom Structure/Periodicity	5 disks	24 programs
Series 300	Bonding/Formulas/Stoichiometry	5 disks	20 programs
Series 400	Solids/Liquids/Gases	3 disks	12 programs
Series 500	Solutions Processes/Acid-Base	3 disks	15 programs
Series 600	Chemical Rxs/Equilibrium-Kinetics-Redox	6 disks	23 programs
Series 700	Organic Chemistry	14 disks	33 programs
Series 800	Environmental/Industrial Chemistry	9 disks	10 programs
Series 900	Analytical/Qual.	1 disk	6 programs
Series 1000	Nuclear Chemistry	1 disk	2 programs
Series 1200	Disks for Laboratory Modules	5 disks	5 programs
Series 1500	Programmers Tools	1 disk	5 programs

Series 100 Summary: Most of the 20 programs in this series are tools for the teacher to use, such as a graphics utility, lab data checker, data table and graph producer, least squares analysis, quiz producer, test grader, and calculator of complex chemical equilibrium problems. With help, advanced students could make use of some of the programs in this series.

Series 200 Summary: About half of the 24 programs in series 200 could be useful for high school chemistry teachers and students. Included in these are programs that graphically illustrate the Bohr model of the atom; games on terminology; analogy to Rutherford's experiment (simulation); tutorial on atomic orbitals; calculation of isotope patterns based on chemical formulas; calculation of mass percent composition; Millikan oil drop simulation; chemistry version of "Trivial Pursuit." This series is much more suited to high school chemistry.

Series 300 Summary: Most of the 20 programs in this series could be used in high school chemistry. There are drills on inorganic nomenclature; graphics package to display and rotate molecular structures; excess reagent simulation; drill on naming and writing elements and compounds; drill on mole problems; drill on molar masses; drill on balancing equations; problem generator on mole-mole stoichiometry; and other games and drills.

Series 400 Summary: Through simulations and games, Boyle's and Charle's laws are illustrated nicely. These programs could be very useful for high school chemistry.

Series 500 Summary: Tutorials, simulations, and games make this series a valuable tool for high school chemistry. Among the programs in this series are a problem generator on calculation of pH; tutorial on Bronsted/Lowry acid-base theory; simulation of a lab that shows molecular weight determination by melting point depression; simulation of potentometric acid-base titration; quiz on concentrations; drill on acid-base problems; simulation of acid dissociation; problem generator on molarity of solutions; tutorial and simulation on pH; and other games and quizzes.

Series 600 Summary: Chemical equilibrium is a very important organizing concept and many useful programs are contained in this series. About 2/3 of the 23 programs can be used for high school chemistry; the others deal with advanced concepts (thermodynamics, molecular speed distribution, ion transport, reactions where kinetic and thermodynamic control operate) that might be dealt with in a second chemistry course. Among the programs in this series are simulation of equilibrium involving changing concentrations; kinetics simulation; game on questions about aqueous equilibria; simulation of Faraday's law; simulation of methane and chlorine reaction; simulation on reaction rates; chemistry version of chemical dungeons; and other simulations and tutorials.

Series 700 Summary: Very little of this series on organic chemistry would be useable in most first courses in high school chemistry. The drills and tutorials on common functional groups and reactions might be useful in an advanced high school course.

Series 800 Summary: If environmental and industrial chemistry are included in the high school course, most of these 10 programs would be useful. They include simulations, games and tutorials on solar space heating, sulfuric acid manufacture, waste treatment, octane of gasoline, water pollution, oil refining, mineral resources, and chromotography.

Series 900 Summary: Both programs in this series could be used in high school chemistry. "Chemical Search" is a game in which the computer knows facts about 18 common substances and the user attempts to identify it. "Chemprop" provides practice in distinguishing similar compounds by common tests.

Series 1000 Summary: One simulation of radioactive decay and one drill on radioactive decay make up this series.

Series 1200 Summary: Each of the 3 disks in this series (laboratory modules) has programs that can be used with lab interface devices to collect and analyze data. Related documentation provides details on constructing the interfaces and using the programs.

Series 1500 Summary: This disk contains 5 programs that can be used by the teacher or student to write chemistry programs. "Chemutil-2" allows the user to write upper and lower case letters and subscripts and superscripts; "Rgetit" provides routines in Basic to handle input from the keyboard; "Data Entry" gives examples of how to handle keyboard input; "Idealgas" is a specific example of how keyboard input might be handled; and "Graphics Utilities" contains programs to create, merge, and rearrange shape tables.

In summary, Project SERAPHIM offers a wide range of chemistry software for high schools and colleges. The 60+ disks are $5 each and contain many different kinds of programs useful to chemistry teachers and students. The SAMS Lab offers workshops to help teachers become acquainted with the materials. At the workshop or at the SAMS Lab on the campus of Florida State University, the disks may be copied for use by chemistry teachers in Florida. Because SERAPHIM materials are essentially free and because many programs can be effectively used by high school chemistry teachers, the SAMS Lab highly recommends that these materials be acquired by all chemistry teachers in Florida for use in their classes.

Commercial Software

The SAMS Lab has evaluated about 1/4 of the 237 entries in the 1986-87 TESS and these 60 or so pieces of chemistry software are available for inspection on the FSU campus. Table 2 identifies these programs by title and also lists grade levels, type of software, publisher and price. The instructional contents of these listings are summarized and evaluations in the form of SAMS Lab profiles follow Table 2.

TABLE 2

CHEMISTRY SOFTWARE (COMMERCIAL) AT THE SAMS LAB

TITLE	SUBJECT	GRADE	TYPE	PUBLISHER	PRICE
ACID BASE PROBLEMS	CHEM	10-13	TUT	J&S	28.00
ACID-BASE CHEM.	CHEM	9-12	DRL	PFL	128.00
ACIDQ	CHEM	9-14	DRL	PFL	30.00
ALCOHOLS	CHEM	11-15	TUT, SIM	COMP	70.00
ALDEHYDES & KETONES	CHEM	11-15	TUT, SIM	COMP	70.00
ALKANES & ALKENES	CHEM	11-15	TUT, SIM	COMP	70.00
ARENES	CHEM	11-15	TUT, SIM	COMP	70.00
ATOMIC ORBITALS	CHEM	10-16	TUT	EDUTECH	95.00

Table 2 Continued

ATOMIC STRUCT.	CHEM	9-12	SKS, SIM	PFL	128.00
ATOMIC WEIGHTS	CHEM	11-14	TUT, SIM	COMP	70.00
BALANCING EQUATIONS	CHEM	10-14	TUT	COMP	70.00
BONDING BTW, MOLECULE	CHEM	10-14	TUT	J&S	28.00
CARBOXYLIC ACIDS	CHEM	11-15	TUT, SIM	COMP	70.50
CHEM LAB SIM #1	CHEM	11-15	SKS, SIM	HITECH	100.00
CHEM LAB SIM #2	CHEM	11-15	SKS, SIM	HITECH	100.00
CHEM LAB SIM #3	CHEM	11-15	SKS, SIM	HITECH	100.00
CHEM LAB SIM #4	CHEM	9-12	TUT, SIM	HITECH	100.00
CHEM. WITH A COMPUTER	CHEM	9-12	SKS, SIM	PFL	128.00
CHEMAZE	CHEM	10-16	GAME	COMP	50.00
CHEMICAL PRINCIPLES	CHEM	9-12	TUT	MWC	24.95
CHEMISTRY DEMOCOMP	CHEM	10-14	TUT, SIM	FOCUS	89.00
CHEMISTRY SERIES I	CHEM	8-13	TUT, GAM	FOCUS	39.00
CHEMRAIN	CHEM	11-15	GAME	COMP	35.00
ENZKIN	CHEM	11-16	TUT, SIM	CON	45.00
ENZYME INVESTIGATION	CHEM	10-14	TUT, GAM	HRM	70.00
EXP. IN CHEMISTRY	CHEM	11-15	SIM, CMP	HRM	349.00
GAS LAW ANALYSIS	CHEM	10-15	CPT	MICRPH	20.00
GEN. DATA ANALYSIS	CHEM	10-15	SKS, SIM	COMP	42.50
GEORGE	CHEM	10-13	SKS, TUT	COMP	51.00
HABER	CHEM	11-14	TUT, SIM	CON	45.00
HABER TECH	CHEM	10-15	SKS, SIM	COMP	70.00
HIEQ	CHEM	10-14	TUT, SIM	PFL	30.50
IDEAL GASES	CHEM	10-15	TUT, SIM	COMP	70.00
IDENT. ORG. COMP I&II	CHEM	10-15	TUT, SIM	COMP	107.00
INTRO CRYSTALLOGR (2)	CHEM	10-15	TUT	COMP	100.00
IR & NMR SPECTROSCOPE	CHEM	11-15	TUT, SIM	COMP	60.00
KINETICS	CHEM	11-14	TUT	J&S	28.00
LAB STATIST. PACK	CHEM	9-14	DEMO	HIGHTE	50.00
MODELER	CHEM	10-14	SIM	COMP	75.00
MOLECULAR ANIMATOR	CHEM	10-16	TUT, SIM	COMP	95.00
MOLECULAR ORBITALS	CHEM	10-15	SKS, TUT	EDUTEC	95.00
MOLES AND FORMULAS	CHEM	10-14	TUT	J&S	28.00
NOMENCLATURE	CHEM	11-15	TUT, SIM	COMP	75.00
NUCLEIC ACID CONNECT	CHEM	9-15	TUT, SIM	COMP	70.00
ORG. STEREO-CHEM.	CHEM	10-14	TUT, SIM	COMP	75.00
ORGAN. QUAL. ANALYSI	CHEM	11-15	SKS, SIM	COMP	100.00
ORGANIC CHEMISTRY (7)	CHEM	10-15	TUT	J&S	28.00/DISK
PERCENT COMPOSITION	CHEM	11-14	TUT, SIM	COMP	70.00
PERCENT CONCENTRAT.	CHEM	11-14	SKS	MICROP	25.00
PERIODIC TABLE	CHEM	10-13	TUT	COMP	28.00
PH CONCEPT	CHEM	11-14	SKS	MICROP	20.00
PH PLOT	CHEM	10-15	CMP.T	CDL	75.00
PH: ACIDS & BASES H20	CHEM	10-14	GAME, TU	COMP	70.00
RKINET	CHEM	11-16	SKS, SIM	CON	45.00
RYDBRG	CHEM	9-14	DRL	PFL	30.00
SPECTRAL UTILITY	CHEM	10-15	TUT, SIM	COMP	40.00
STOICH. ANAL.	CHEM	11-12	CPT	MICRPH	20.00
SUBSTITUTION REACT.	CHEM	11-15	TUT, SIM	COMP	70.00
VSEPR	CHEM	9-14	DRL	PFL	30.00
WRITING CHEM, FORM	CHEM	10-14	SKS, TUT	MWC	35.00

Four publishers (Compress, Programs for Learning, Microphys, and J&S Software) produce more than half of the commercially available chemistry software in the U.S. Microphys produces mostly skills practice software that presents students with various problems and questions and then keeps records of students' performance. Programs for Learning offers 4 sets of chemistry programs that concentrate on skills practice and tutorials: (1) Acid-Base Chemistry, $150 for an 11-program (1 disk) set; (2) Chemistry with a Computer, 12-program (1 disk) set for $150; (3) Atomic Structure, 9-program set (1 disk) for $150; and (4) Chemical Equilibrium, 10-program set for $150.00

Compress, at least for now, seems to be the leader in producing quality chemistry software. Their comprehensive sets of tutorials are of high quality and other specialized disks such as Molecular Animator and George are of similar quality.

The software that has been selected by the SAMS Lab for evaluation represents less than 5% of the available commercial software, so some good software obviously is not included. As a supplement to the SERAPHIM software already reviewed, the following chemistry software would provide excellent teaching/learning resources.

Program 1

Title: Introduction to General Chemistry
Publisher: Compress
Cost: $590.00 (10 disks)
Computer Required: Apple II+/IIe
Grade Levels: 10-14

Instructional Content:

The high cost of this set of tutorials/simulations may be beyond the budgets of many schools. Nine of the ten disks are tutorials with excellent graphics and user-friendly text, designed to help students learn about the periodic table, nomenclature, balancing equations, atomic weights, percent composition, pH, and other content commonly found in chemistry textbooks. Although most of what is found on the disks can be done by teachers and textbooks, the tutorials are very well done. They represent the "state-of-the-art" in computer-assisted instruction. Unlike many simulations, however, they do little that cannot be done by other instructional materials. Each of the 10 disks may be purchased for $70.00

Technical Quality: Excellent

SAMS Lab Profile:

Instructional Value . . . . . HIGH
Interest to Students. . . . . GOOD
Technical Quality . . . . . HIGH
Cost. . . . . HIGH
Copy Protection . . . . . YES
List Protection . . . . . YES
Documentation . . . . . NONE

Program 2

Title: George: A Problem Solver
Publisher: Compress
Cost: $60.00
Computer Required: Apple II+/IIe
Grade Levels: 10-14

Instructional Content:

For a wide range of problems, George does the calculations and supplies the answer. The students must identify the information available and the nature of the answer to be obtained, and must supply implicit relationships. If George needs more information, the student is asked certain questions. If students wish, George can explain how an answer was obtained by using words and diagrams. This helps the student see the relationship between the answer and the information supplied. the potential of George-like programs as problem-solving tutors is very high.

Technical Quality: Good

SAMS Lab Profile:

Instructional Value . . . . . HIGH
Interest to Students. . . . . HIGH
Technical Quality . . . . . GOOD
Cost. . . . . MODERATE
Copy Protection . . . . . YES
List Protection . . . . . YES
Documentation . . . . . GOOD

Program 3

Title: Modeler: Molecular Design Editor
Publisher: Compress
Cost: $60.00
Computer Required: Apple II+/IIe
Grade Levels: 10-16

Instructional Content:

Similar to other Compress molecular tools (Molecular Animator, $95; Molec.: Molecular Modeling, $150), this software is priced lower and offers very nice graphics and relatively easy commands to create, display, edit, and manipulate 3-D views of molecules. Atoms can be color coded and the molecules can be rotated about any of the three Cartesian axes. Also, bond lengths and angles may be altered. Special twist and fuse commands alter molecules and create complex ring structures. This is a very useful tool that does what conventional instructional media cannot.

Technical Quality: Very good

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH
Technical Quality	VERY GOOD
Cost	MODERATE
Copy Protection	YES
List Protection	YES
Documentation	GOOD

Program 4

Title: Chem Lab Simulation #2
Publisher: High Technology
Cost: $100.00
Computer Required: Apple II+/IIe
Grade Levels: 10-14

Instructional Content:

The ideal gas law (PV = nRT) is an important and often difficult part of high school chemistry. It is difficult because it is based on a rather abstract model (Kinetic-molecular) that explains many observable phenomena. In the ideal gas law simulation the student controls the number of particles, the temperature, and the volume of the container. By changing one of the variables the movement of the particles can be observed and readouts at the bottom of the screen are monitored. A simulation can be selected that shows the interactions one particle as with the others in the container. The diffusion of gases shows how gases gradually reach an equilibrium state. Although this software was developed in 1979 it still offers valuable help with a difficult topic.

Technical Quality: Good

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH
Technical Quality	GOOD
Cost	HIGH
Copy Protection	YES
List Protection	YES
Documentation	GOOD

Program 5

Title: Experiments in Chemistry
Publisher: Human Relations Media (HRM)
Cost: $349.00
Computer Required: Apple II+/IIe/IIc
Grade Levels: 9-14

Instructional Content:

Although the cost of this software/hardware package is high, the quality is high as well. A MICRO/scope box with 8 single probe sockets and 2 16-pin

ribbon cable sockets, a pH/mV meter, a temperature probe, and related cables and clips provide the necessary hardware. The software disk allows for a wide range of options for data collection, analysis, and presentation. A comprehensive guide (141 pp.) provides background and documentation to prepare for the 15 experiments described in the guide. Four experiments use the temperature probe (cooling curve, specific heats, freezing-point depression, heats of neutralization), 7 experiments use the pH meter (basic measurements, strong base titration, strong acid titration, weak acid titration, antacid analysis, vinegar analysis, carbonate titration), and 4 experiments use the mV meter (basic EMF, potentionmetric titration, standard redox potential, redox titrations). If you can afford it, this package could be helpful in lab and demonstration settings.

Technical Quality: Very good, but requires careful setup and study of commands for proper use.

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH
Technical Quality	HIGH
Cost	VERY HIGH
Copy Protection	YES
List Protection	YES
Documentation	VERY GOOD

Program 6

Title: RKINET: Reaction Kinetics
Publisher: Conduit
Cost: $45.00
Computer Required: Apple II+/IIe/IIc
Grade Levels: 11-16

Instructional Content:
This skills-practice/simulation software allows students to explore reaction kinetics beyond what might normally be done in the laboratory. Since the teacher may make multiple copies, many students could work with RKINET at the same time, if the hardware were available. Students find the effects of initial concentrations and temperature on reaction rate; the meaning of order of a reaction; the connection of a mathematical model with empirical results; and many other things related to reaction kinetics. Any of fifteen simulations of chemical reactions can be selected for investigation or one of the student's lab experiments may be used. Initial temperature, concentration, and interval between readings are selected by the student and tabular or graphical output results for the specific reaction.

Technical Quality: Very good

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH (for more capable students)
Technical Quality	HIGH
Cost	MODERATE
Copy Protection	NONE (for an institution)
List Protection	NO
Documentation	MINIMAL

Program 7

Title: General Data Analysis Routine
Publisher: Compress
Cost: $43.00
Computer Required: Apple II+/IIe/IIc
Grade Levels: 10-16

Instructional Content:

This is one of a number of data analysis packages that can be very useful in laboratory work. The operations in this software include options for modifying data before plotting, printing both original and transformed data, and predicting X-values by entering Y-values. The transform option operates on X and/or Y arrays and includes addition, subtraction, multiplication, division, raise to a power, natural log, base 10 log, and trading X-Y data pairs. This is a nice menu-driven, data-analysis package at a reasonable cost.

Technical Quality: Very good

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH
Technical Quality	HIGH
Cost	MODERATE
Copy Protection	YES
List Protection	YES
Documentation	GOOD

Program 8

Title: Quantum Chemistry I and II
Publisher: EduTech
Cost: $95.00 each
Computer Required: Apple II+/IIe
Grade Levels: 11-16

Instructional Content:

Quantum Chemistry I (Atomic Orbitals) is a tutorial designed to help students study s, p, and d atomic orbitals and certain hybrids. Although there is extensive documentation, the abstract nature of the content would require considerable teacher guidance for most students. The user inputs quantum

numbers (N, L, M), and nuclear charge (Z), initial and maximum radial distances (e.g. 0, 3), and increment to determine the number of points (maximum of 41) to be plotted. Calculations are then done and the various orbital functions, including orbital contours, can be listed in tabular form and graphed.

Quantum Chemistry II (Molecular Orbitals) is an extension of Atomic Orbitals. The calculations take much longer, resulting in delays that might be annoying to some students. Orbital contour plots can be shown for certain molecular orbitals. With proper structure and guidance from the teacher, these programs could be helpful, especially with more advanced students.

Technical Quality: Good

SAMS Lab Profile:

Instructional Value . . . . . HIGH
Interest to Students. . . . . GOOD (for advanced students)
Technical Quality . . . . . GOOD
Cost. . . . . HIGH
Copy Protection . . . . . YES
List Protection . . . . . YES
Documentation . . . . . VERY GOOD

Program 9

Title: Writing Chemical Formulas
Publisher: Microcomputer Workshops Courseware
Cost: $30.00
Computer Required: Apple II+/IIe/IIc
Grade Levels: 10-14

Instructional Content:

Practice in writing chemical formulas is provided with 121 different formulas (11 metals and 11 nonmetals). Help is provided with symbols, oxidation states and total ions needed. If the student is still unsuccessful after the tutorial, the correct answer is provided. After the chart containing the necessary information for each element is completed, the student is again asked to write the formula for the compound. The student's errors per problem, number of problems attempted, and total errors are provided.

Technical Quality: Good

SAMS Lab Profile:

Instructional Value . . . . . HIGH (for less advanced students)
Interest to Students. . . . . MODERATE
Technical Quality . . . . . GOOD
Cost. . . . . LOW
Copy Protection . . . . . YES
List Protection . . . . . YES
Documentation . . . . . BRIEF

Program 10

Title: Identification of Organic Compounds
Publisher: Compress
Cost: $107.00 (2 disks)
Computer Required: Apple II+/IIe/IIc
Grade Levels: 10-16

Instructional Content:

Disk 1 in this set provides information on chemical and spectral analysis of 17 major functional groups. The strategy for identifying unknown organic compounds is: (1) do diagnostic tests, (2) do confirmatory tests, (3) do derivative formation, and (4) do spectral analysis. A qualitative analysis scheme is outlined and tests are identified for physical properties, solubility characteristics, and combustion products. A quiz at the end of the menu describes tests and results and the student must choose the functional group that is implicated. Disk 2 is a laboratory simulation that allows the student to perform tests and observe results for an unknown functional group. Then a functional group must be selected. If successful, the student goes on to prepare derivatives and record spectra. If unsuccessful, more diagnostic or confirmatory tests must be tried.

Technical Quality: Very good

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH
Technical Quality	VERY GOOD
Cost	MODERATE
Copy Protection	YES
List Protection	YES
Documentation	GOOD

Other Chemistry Software and Ideas for Teaching

Tutorials in chemistry software are not in short supply. Even the best, however, do little that a teacher and conventional instructional media cannot. The main advantage is the individual attention given to the student and the potential as a review or practice medium. If the software is highly interactive and can adjust to the student's level, this is a very important advantage. Few offer this kind of flexibility, however.

Other software worth considering include Haber by Conduit ($45; simulation of ammonia synthesis where student controls temperature, pressure, catalyst, and concentrations), Enzkin by Conduit ($45; simulated enzyme-catalyzed reactions), Chemrain by Compress ($35; game involving reactions with organic compound; part of an 8-disk set that covers important organic chemistry information; $357/set), Ideal Gases by Compress ($70; tutorial/simulation where student collects and interprets data and solves problems), RKINET by Conduit ($45; simulation using data from real experiments; involves 1st- and 2nd-order reactions, rate constants, concentrations, and temperature effects), and Chemical Equilibrium by Programs for Learning ($150 for 10-program set; tutorials and simulations on equilibrium).

For nearly any topic in high school chemistry there is computer software available to supplement regular classroom activities. Many programs could be used effectively as demonstrations while others are intended for individual use. The important thing to remember is use software that extends what you can normally do in the classroom rather than simply replacing one lecture for another.

PHYSICS SOFTWARE

Because of the mathematical nature of much of physics, the computer as "number cruncher" is very well-suited to helping students experience new ways of learning. Most of the physics software is designed for high school and introductory college physics, but some of it can be used with advanced middle school students.

Nowhere is learning science as problem solving more appropriate than in physics. Completed software now available for physics teaching includes many simulations of systems that can be very helpful to students. Most simulations allow students to input values for the different variables of the system and then see how the system operates. No simulation should replace a real lab in physics or any other science, but they can supplement labs and, in many cases, go beyond what can be accomplished by regular labs, lectures, etc. Another type of software that is becoming more common is the computational tool used to collect, analyze, and display data. Earlier, Broderbund's "Science Toolkit" was mentioned as a very nice "tool" for use in experiments where temperature and light intensity were of concern. The light probe (photocell) is a very useful device in physics because it can be used either in optics/light or in motion experiments as a photogate. Other interface packages for use in physics are described in this section.

What Is Available?

Of the common topics in physics (heat, light, motion, etc.), motion has much more instructional software devoted to it than the other categories. Since the computer can solve differential equations very quickly, it is not difficult to see why simulations of various kinds of motion are common in much physics software. More than a third of all instructional software in physics is devoted to mechanics. Table 3 shows the SAMS Lab software in physics and about 1/3 of it deals with mechanics.

Of the handful of software publishers that produce most of the quality physics materials, two of them deserve special mention here because of their low prices and high quality. Cross and Vernier (VERN in Table 3) each produce nice software at very reasonable prices.

Cross Physics Software

Among the earliest software for physics instruction, Cross tutorial/simulations are well done and provide good information/practice in problem solving. Five of the 16 disks are devoted to mechanics: Vectors and Graphing, Statics, Motion, Conservation Laws, and Circular Motion ($20.00 each). Each package comes with a disk and brief guide. A step-by-step tutorial is presented on each disk, accompanied by graphics depicting the event(s) being studied. Following the tutorials, problems are depicted using dynamic graphics and they are solved using the methods presented in the tutorials. Some interaction occurs with the student during the tutorials and problem solving, but it is not extensive and the student must go through the entire problem sequence before returning to the menu. These programs are for the serious high school student and freshman college students. The other 7 disks in the set are: Thermodynamics ($20), Electricity and Magnetism ($20), Optics $20), Atomic Physics ($30), Stellar Astronomy ($30), and a potpourri of 32 programs that deal with

physics topics, Physics Gems ($35). They can be ordered individually or as a set in a notebook ($260).

Table 3

PHYSICS SOFTWARE AT THE SAMS LAB

ADVANCED PHYSICS	PHY	10-16	COMP TOOL	EDUTEC	60.00
ATOMIC PHYSICS	PHY	9-14	TUT, SIM	CROSS	30.00
ATOMS & MATTER	PHY	11-14	SKS, TUT	FOCUS	119.00
BASIC CONCEPTS ELECT	PHY	8-12	TUT	MERLAN	80.00
BASIC ELECTRICITY	PHY	10-15	SIM	PFL	50.00
CHARGED PART. WORKS.	PHY	11-14	SIM	HITECH	75.00
CHARGED PARTICLES II	PHY	11-14	SIM	VERN	24.95
CIRCULAR MOTION	PHY	11-14	TUT, SIM	CROSS	20.00
COLLIS & HARMON. MOT.	PHY	11-14	TUT, SIM	EME	35.00
COMPLEX CIRCUITS	PHY	11-15	TUT, SIM	EME	40.00
CONSERV. ENER. & MOM.	PHY	11-14	TUT, SIM	EME	42.00
CONSERVATION LAWS	PHY	11-14	TUT, SIM	CROSS	20.00
DENSITY/RUTHERFORD	PHY	11-14	TUT, SIM	EME	40.00
ELEC. & MAGNETISM	PHY	11-14	SKS, TUT	CROSS	20.00
ELEC & MAGENTISM	PHY	11-14	SKS, TUT	FOCUS	79.00
ELECTRIC FIELD	PHY	11-14	TUT, SIM	EDUTEC	75.00
ELECTRICITY	PHY	11-14	SKS, TUT	CROSS	20.00
ELECTRICITY: SERIES I	PHY	9-12	DRL, TUT	MERLAN	80.00
ENERGY	PHY	8-12	TUT, SIM	FOCUS	69.00
FLIGHT VECTOR	PHY	8-14	SKS, SIM	EDUSOF	24.95
FOURIER ANAL. I&II	PHY	12-16	CMPT	EDUTEC	190.00
FREE FALL	PHY	9-14	SIM, CMP	ED'L.C	36.00
FREQUENCY METER	PHY	11-14	CMP, TOOL	VERN	39.95
GRAPHICAL ANALYSIS II	PHY	9-16	CMP, TOOL	VERN	24.95
GRAPHING AND UNCERT.	PHY	11+	TUT, UTI	FOCUS	20.00
GROUP VELOCITY	PHY	13-15	SIM, DEM	CON	60.00
HARMONIC MOT. WORKSH.	PHY	11-14	SIM	HITECH	75.00
HEAT	PHY	11-15	CMPTOOL	EME	44.00
HEAT ENERGY	PHY	11-15	SKS, SIM	FOCUS	59.00
INTERP	PHY	9-14	SKS, TUT	CON	45.00
INTRO MECH/APP. II	PHY	11-15	DEMO, SK	CON	55.00
KINEMATICS II	PHY	11-14	SKS, SIM	VERN	24.95
LAB INTERFACE-HEAT	PHY	11-14	SK, CMP	CROSS	60.00
LAB INTERFACE-LIGHT	PHY	11-14	SK, CMP	CROSS	60.00
LAB INTERFACE-SOUND	PHY	11-14	SK, CMP	CROSS	60.00
LAWS OF MOTION (2)	PHY	11-14	TUT, SIM	EME	103.50
LENSES	PHY	10-14	SIM	SCOTT	59.95
LIGHT WAVES	PHY	11-14	TUT, SIM	EME	55.00
MECHANICS	PHY	11-14	SIM	EDUTEC	60.00
MOTION	PHY	11-14	SKS, TUT	CROSS	20.00
MOTION I & II	PHY	8-11	SKS, TUT	MCW	39.95
NEWTON	PHY	11-15	SIM, SKS	CON	45.00
NON-LINEAR MOTION	PHY	11-14	SKS, SIM	FOCUS	89.00
NONCONSTANT ACCELER.	PHY	11-14	SIM, CMP	EDUTEC	75.00
OIL DROP	PHY	11-14	SKS, SIM	EDUTEC	75.00

Table 3 Continued

OPTICS	PHY	11-14	TUT, SIM	CROSS	20.00
OPTICS	PHY	11-14	TUT, SIM	EDUTEC	98.00
OPTICS AND LIGHT	PHY	11-14	SKS, SIM	FOCUS	79.00
OPTICS-WAVES-ELECTRI	PHY	11-14	SIM	EDUTEC	60.00
ORBIT II	PHY	9-14	SIM	VERN	24.95
PARABOLIC MOTION	PHY	11-14	SIM	EDUTEC	75.00
PENDULUM	PHY	11-14	TUT, SIM	EDUTEC	75.00
PHYSICS LAB PLOTS	PHY	10-14	TUT, CMP	ED'L.C	36.00
PHYSICS SERIES (3)	PHY	11-14	TUT, SIM	EDC	108.00
PLANETARY MOTION	PHY	11-15	SIM	EDUTEC	75.00
PLANETARY ORBITS	PHY	11-16	SIM, CMP	EDUTEC	75.00
PRECISION TIMER II	PHY	11-16	TCRA,CP	VERN	39.95
PROJECT. & CIRC. MOT.	PHY	11-14	TUT, SIM	EME	40.00
PROJECTILE MOT. WORK.	PHY	11-14	SIM	HITECH	75.00
PROJECTIVES II	PHY	11-14	SIM	VERN	25.00
RAY TRACER	PHY	11-14	TCRA, DE	VERN	24.95
SCATTER	PHY	11-14	SKS, SIM	CON	45.00
SCIENCE SIMULATIONS	PHY	10-14	SIM	MPL	39.95
SOLAR SYSTEM ASTRON	PHY	9-14	TUT	CROSS	30.00
SPACE STATION	PHY	9-14	SKS, SIM	EDUTEC	75.00
STATICS	PHY	11-14	SKS, TUT	CROSS	20.00
STATISTICS	PHY	11-14	SKS, SIM	EDUTEC	75.00
STELLAR ASTRONOMY	PHY	9-14	TUT, SIM	CROSS	30.00
TARGET	PHY	11-14	SKS, GAM	EDUTEC	75.00
TEMPERATURE	PHY	11-14	CMPT	EDUTEC	75.00
THERMODYNAMICS	PHY	11-14	SKS, TUT	CROSS	20.00
THREE BODY ORBITS	PHY	11-15	SIM	EDUTEC	75.00
VECTOR	PHY	11-14	TCRA, DE	EDUTEC	75.00
VECTOR ADDITION II	PHY	11-15	DEMO	VERN	24.95
VECTORS & LINEAR MOT.	PHY	11-14	SKS, SIM	FOCUS	90.00
VECTORS AND GRAPHING	PHY	9-14	DRL, TUT	CROSS	15.00
VIBRATIONS & WAVE MOT	PHY	11-15	SKS, SIM	FOCUS	99.00
VOLTAGE PLOTTER	PHY	11-15	TOOL	VERN	39.95
WAVE ADDITION	PHY	11-15	DEMO	VERN	24.95
WAVE MOTION	PHY	11-14	SIM	EDUTEC	75.00
WAVES & VIBRATIONS	PHY	10-15	SIM	MERLAN	60.00

Three interface packages, Physics Lab-Light, Heat, Sound ($60 each) come as kits to be assembled and are used to collect and analyze data in labs. Although the price is reasonable and the devices work fairly well once assembled, they are rather fragile and do not hold up well in the hands of high school students.

If you are looking for problem-solving tutorials at a reasonable price, the Cross physics programs are a good buy.

Vernier Physics Software

Like Cross software, Vernier software is relatively inexpensive (most packages are $25) and it is not list- or copy-protected within a school. The documentation with Vernier physics software is very good, including background

information and descriptions of the computer programs that cause the software to run. David Vernier includes suggestions to modify the program code to see how program execution is changed. This is a nice feature not found in other physics software. Most students are very interested in what makes the program "tick."

Brief descriptions of each of the 12 Vernier programs (for the Apple computer) follow:

1. Charged Particles II: ($24.95). Students experiment with the motion of charged particles in magnetic and electric fields. A 27-page manual includes student worksheets, problem solutions, 8 "challenges" to the student, and background information on program structure and code.

2. Frequency Meter: ($39.95). This software "tool" can be used to display audio frequencies and to make measurements of voltage, temperature, and light intensity. Sound is fed to the Apple's cassette input port using a microphone and tape recorder. Using photogates, Frequency Meter can be used to measure the speed and acceleration of objects.

3. Graphical Analysis II: ($24.95). Data are input at the keyboard or from a disk and displayed as a graph, including linear regression "best fit" lines and semi-log and log-log graphs. A 25-page manual provides much useful information.

4. Kinematics II: ($24.95). Dynamic graphics show a truck that travels along a straight line. The student controls the distance, starting speed, and acceleration. As the truck moves a dot appears behind it every second and the screen shows elapsed time, speed, distance, acceleration, and, finally, average speed is shown. An 18-page manual contains helpful suggestion and possible program modification (by listing and changing program code). Three utility programs include Large Print (so entire class can see numbers), Binary (displays numbers as decimal, binary, and binary bit patterns), and Calculator (four-function calculator displayed in large digits).

5. Orbit II: ($24.95). Satellite motion is simulated after the student inputs launch speed and angle. Heading, speed, and distance from earth are displayed and course corrections may be made from the keyboard. Nine challenges to the student and other information are contained in the 23-page manual.

6. Precision Timer: ($39.95). When used with photogates this software can be used to measure and display data for many motion experiment, including collisions. A 43-page guide provides many suggestions for use, photogate construction (a $40 kit is available), and program design notes.

7. Projectiles II: ($24.95). This simulation allows students to experiment with projectile motion. Various "challenges" to the students provide many variations, including moving targets, wind and air resistance. As the projectile motion is displayed, height above the ground, range, and elapsed time are shown for each menu data point on the graph. A 21-page guide includes solutions and notes on the 9 challenges and program-design notes to make it easier to modify the programs.

8. Ray Tracer: ($24.95). The student chooses the transfer medium (e.g. air, water) and optical devices the ray will encounter (e.g. thin/thick lenses, compound lenses, plane/spherical mirror). Angles of incidence and refraction (or reflection) are indicated below the ray diagrams. This simulation package includes the disk and a 19-page guide.

9. Temperature Plotter: ($39.95). This interface package allows up to 4 temperatures to be measured at the same time (2 for the Apple IIc). A kit is available ($30.00) or the probes and circuit can be built from locally available materials, using the 53-page manual as a guide.

10. Vector Addition II: ($24.95). Up to 19 vectors may be added or subtracted using this software. The student enters magnitude and direction for each vector, arrows are drawn, and the resultant vector is drawn, with its magnitude and direction printed below the arrow array. This is a very useful tool for students to use.

11. Voltage Plotter: ($39.95). With a voltage input unit ($25) this lab interface program may be used for a wide array of electrical experiments. A 68-page manual contains many suggestions for experiments, program design notes, and information on the 14 modes of program operation.

12. Wave Addition II: ($24.95). Up to 9 waves may be added to demonstrate superposition. The student may use demos or enter the values for frequency, amplitude, and phase angle. As with all Vernier software, the manual includes program design notes and suggestions for modifications in the program.

Because of the high quality, low cost, very good documentation, and no list or copy protection (within a school), Vernier physics software is a very good choice.

Evaluation of Selected Software

Other publishers of physics software also have good products. EduTech, for example, has a number of very nice programs, including interface devices. HiTech, EME, Conduit and others also offer quality physics software, but the prices are generally 2 or 3 times the cost of the Cross and Vernier software. Examples of some of this software are now presented and evaluated.

Program 1

Title: Harmonic Motion Workshop
Publisher: High Technology
Cost: $75.00
Computer Required: Apple II+/IIe
Grade Levels: 10-14

Instructional Content:
Simple and damped harmonic motion are simulated using very good dynamic graphics. A horizon oscillator moves while the student inputs commands to

display velocity vectors, acceleration vectors, or kinetic and potential energy at each step in the cycle. In addition to the horizontal oscillator, the user may select a vertical oscillator or a circular motion oscillator. A time plot command allows the student to see the relationship between SHM and the time required for the oscillator to move through the various phases of its cycle. One of the six programs shows two horizontal oscillators that are in phase until the user types commands to change the amplitude and/or the phase. This is an excellent demonstration of the effects of changing amplitude or phase on SHM. A similar program adds a pair of circular oscillators. Harmonic Motion Workshop is an excellent example of using the computer to do what textbooks and ordinary instructional media cannot. The related Projectile Motion and Charged particle Workshops use a similar approach in simulating important and normally difficult concepts in physics.

Technical Quality: Excellent

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH
Technical Quality	EXCELLENT
Cost	HIGH
Copy Protection	YES
List Protection	YES
Documentation	VERY GOOD

Program 2

Title: Advanced Physics
Publisher: EduTech
Cost: $60.00 (with backup disk)
Computer Required: Apple II+/IIe
Grade Levels: 11-16

Instructional Content:

There are three parts to this software - Fourier Synthesis, Three-Body Orbits, and Millikan Oil Drop Experiment. In Fourier Synthesis the user selects one of five periodic waves and chooses to: (1) see a plot of the frequency spectrum; (2) see a plot of the original wave, or (3) plot a waveform from the synthesis of its harmonics. This is a valuable program if Fourier synthesis is dealt with in class, but probably too advanced for independent study except for advanced students. Three-Body Orbits is a nice program that allows the user to select any 2 planets including hypothetical ones, and specify the distance from the sun in astronomical units. For hypothetical planets, mass (in earth units) and perhelion are selected as well. Applications include retrograde motion, Kepler's second law, precession, and orbital capture. With Millikan's oil drop experiment, the student uses game paddles to adjust the voltage difference between the plates and after a number of runs the charge is calculated.

Technical Quality: Very good

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH
Technical Quality	VERY GOOD
Cost	MODERATE
Copy Protection	YES
List Protection	YES
Documentation	GOOD

Program 3

Title: Introductory Mechanics
Publisher: Conduit
Cost: $55.00
Computer Required: Apple II+/IIe/IIc
Grade Levels: 11-15

Instructional Content:

This program provides a very different approach to the study of physics. A 117-page student guide contains physics information and very specific directions for using the computer to solve equations of motion. Students learn to write programs (in Applesoft Basic) while they are learning physics. Fourteen programs on the disk show plots for various kinds of motion including damped and undamped oscillations, projectile motion, orbital motion, and motion in a screened Coulomb potential. These programs plus those provided in the student guide allow the student to understand how the computer can be a very useful tool for learning physics. Each type of motion that is studied uses the computer to solve the equations of motion so that students may better understand the role of mathematics in motion.

Technical Quality: Good

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH
Technical Quality	GOOD
Cost	MODERATE
Copy Protection	YES
List Protection	NO
Documentation	EXTENSIVE

Program 4

Title: Laws of Motion
Publisher: Educational Materials and Equipment (EME)
Cost: $103.50 (2 disks)
Computer Required: Apple II+/IIe/IIc; TRS 80; IBM PC
Grade Levels: 11-14

Instructional Content:

Both disks in this set compare motion in two different worlds - Newtonian and Aristotelian. In the Newtonian world force is linked with change in motion

and in the Aristotelian world, force is linked only to motion. The programs are intended to help students critically analyze "naive" (Aristotelian) theories about motion by presenting contrasting views. Common misconceptions such as "a heavier object falls faster than a lighter object" and "a force is necessary for an object to remain in motion" are challenged by these simulations. A 27-page study guide contains very useful information for the teacher. Some annoying sound effects, unrelated to the simulations, detract from the otherwise good quality of the programs.

Technical Quality: Very good

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH
Technical Quality	VERY GOOD
Cost	MODERATE
Copy Protection	YES
List Protection	YES
Documentation	VERY GOOD

Program 5

Title: Group Velocity
Publisher: Conduit
Cost: $60.00
Computer Required: Apple II+/IIe/IIc
Grade Levels: 13-15

Instructional Content:

Traveling waves of the form Y = cos(WO*T - KO*X) are studied where Y is vertical amplitude, WO is angular frequency, T is time, KO is wave number and X is horizontal position. Game paddles or the keyboard may be used to vary the wave characteristics. This simulation allows the student to see how various wave numbers, frequencies, etc., affect the general form and motion of the traveling waves. A guide contains various exercises that show the student how to explore all of the programs on the disk. For advanced students, this is a very nice instructional aid. Since the programs are not list protected, students may explore the code that controls the simulations.

Technical Quality: Good

SAMS Lab Profile:

Instructional Value	HIGH
Interest to Students	HIGH (for advanced students)
Technical Quality	GOOD
Cost	MODERATE
Copy Protection	YES
List Protection	NO
Documentation	ADEQUATE

Program 6

Title: Non-Constant Acceleration
Publisher: EduTech
Cost: $75.00
Computer Required: Apple II+/IIe
Grade Levels: 11-14

Instructional Content:

In addition to the usual learning activities associated with simulations, students use a stopwatch, take linear measurements from the screen, and program the computer to calculate positions and velocities. The concept of non-constant acceleration is difficult for many students to understand and this software helps make this topic more concrete. Especially for advanced students, this software could be very useful.

Technical Quality: Good

SAMS Lab Profile:

Instructional Value . . . . . HIGH
Interest to Students. . . . . HIGH (for more advanced students)
Technical Quality . . . . . GOOD
Cost. . . . . HIGH
Copy Protection . . . . . YES
List Protection . . . . . YES
Documentation . . . . . GOOD

Program 7

Title: Optics, Waves, and Electricity
Publisher: EduTech
Cost: $60.00
Computer Required: Apple II+/IIe
Grade Levels: 11-14

Instructional Content:

Three separate programs are contained on this disk: (1) Convex Lenses allows the user to change the lens thickness, the lens material, the environment, and the position of the object. An on-screen ruler allows measurements to be made of object, image, etc. (2) Superposition of Waves allows the user to specify wave characteristics and a resulting wave is drawn. A second wave is specified and drawn, followed by their sum (superposition). More waves and superpositions may be added. (3) Two Point Charges demonstrates lines of force and equipotentials surrounding two point charges. A test charge is controlled by the user to reveal lines of force.

Technical Quality: Good

SAMS Lab Profile:

Instructional Value . . . . . HIGH
Interest to Students. . . . . HIGH

Technical Quality . . . . . GOOD
Cost. . . . . MODERATE
Copy Protection . . . . . YES
List Protection . . . . . YES
Documentation . . . . . GOOD

Program 8

Title: Complex Circuits
Publisher: Educational Materials and Equipment (EME)
Cost: $40.00
Computer Required: Apple II+/IIe/IIc
Grade Levels: 11-15

Instructional Content:

The four programs on this disk include: Capacitors in Circuit, Resistors in Circuits, RC Circuit Response, and RCL Circuit Analysis. A series/parallel circuit is shown and then, in a step-by-step tutorial, total capacitance (or resistance) is found. Currents and potential differences are found at various places in the circuits. In RC Circuit Response, the student inputs values for C and R and then plots of successive charges and currents are shown. More functions may be plotted on the same two graphs or the screen can be cleared. The student may select different colors when plotting more than one function on the same charge/current graphs. The final program introduces inductance and students explore the effects of varying the frequency.

Technical Quality: Good

SAMS Lab Profile:
Instructional Value . . . . . HIGH
Interest to Students. . . . . HIGH
Technical Quality . . . . . GOOD
Cost. . . . . LOW
Copy Protection . . . . . YES
List Protection . . . . . YES
Documentation . . . . . GOOD

Other Physics Software and Ideas for Teaching

Our brief reviews of Cross and Vernier software and the 8 programs just "profiled" represent only about 1/8 of the commercially available physics software. If you are looking for software that presents questions and problems and keeps records of students' scores, Microphys has about 25 different programs at $20.00 each. Of course, this type of software does little that worksheets cannot, but it might meet certain needs. Other physics software by Conduit, EduTech, EME, Focus, and a few other suppliers include worthwhile programs for instruction. Clearly, the best way to decide whether a particular piece of software is right for you is to try it. If the publisher allows a "trial" period then only time is lost in the search for quality products. The next section, "Other Software," includes a listing of many science software distributors and information on preview policies, back-up disks, list protection, etc.

OTHER SOFTWARE

As with our previous reviews of biology, chemistry, and physics software, the six categories in this section are limited to software that is available for the Apple II series of computers. While some quality software is not formatted for the Apple II series, most of the good software is written with this hardware in mind.

Earth Science

There are only about 50 pieces of software that deal with weather, the oceans, minerals, the water cycle and other earth science topics. Compared to the quality of the software for biology, chemistry, and physics, earth science software is a good bit below the rest. Perhaps because the earth sciences are not "experimental" in the same sense as the physical and biological sciences, more of the earth science software tends to do little that a textbook cannot. Whatever the reasons, if you are looking for a wide range of high quality earth science software, good luck!

Space Science

Space science is often grouped within earth science, but that practice is misleading. Space science usually involves the study of things apart from the earth such as other planets, stars, etc. There are even fewer software products available for space science than for earth science, but a couple of the astronomy simulations are worth considering. Two by Cross (Solar System Astronomy and Stellar Astronomy) have been mentioned in the Physics section. Another titled, "The Observatory" by Lightspeed (grades 8-14, $49.95) is a simulation that allows the user to "see" our sun, planets, stars, etc., with a software telescope. "Planetary Motion" and "Planetary Orbits" by EduTech (each $75.00) are nice simulations to study Kepler's laws and other physics content. Beyond that, there is very little worth mentioning under the space science heading.

Lab Interface Devices

Interface devices have been developed that use sensitive probes to collect data on changes of temperature, pH, light intensity, velocity, etc., over time. The changes are usually displayed on a plot of the change variable versus time. Most interface devices work by converting analog signals received by tranducers into digital output fed into the computer. Examples of tranducers include termistors, variable resistors, strain gauges, photoresistors, and phototransistors.

The SAMS Lab has purchased several good interface devices developed by Broderbund, HRM, and Educational Electronics. These are briefly described with emphasis on advantages and classroom applications.

The Science Tool Kit by Broderbund is the best buy ($59.95). It includes two sensory probes (a thermistor and a photocell), an interface box, and an excellent user's guide. Several hands-on experiments are described that investigate the effects of temperature and light intensity on living organisms and various physical substances. One attractive feature is the durability of the hardware. The probes and box should hold up under "heavy" student use. Also, the device is

plugged into a rear port of the apple thereby avoiding problems with inserting interface cards. The Science Tool Kit can be used by students in the upper elementary grades and beyond.

Voltage, current, temperature, and magnetic field strength can be investigated using the Electronics Measurement Module by Educational Electronics. Experiments are described that involve cooling curves, state changes, effects of insulation, characteristics of light bulbs, resistors, diodes, magnetic flux, solenoids, etc. For example, the magnetic field versus current can be plotted and the relationship between these two variables determined. The software can be modified by competent programmers using notes on program structure provided upon request. Although the module is expensive ($460.00 from Central Scientific) it has accurate and durable instruments that will interface with most microcomputers.

HRM software such as Experiments in Chemistry ($349.00), Experiments in Science ($259.00), Experiments in Human Physiology ($259.00), and Cardiovascular Fitness Lab ($165.00) can be used by students in biology, physics, chemistry, physiology, psychology, earth science, health, and athletic classes. Excellent Teacher Guides describe exercises involving recording and observing plots of heart rate, respiration rate, skin temperature, reaction time, light intensity, humidity, pH, mV, temperature, etc., as they change over time under a variety of conditions. Objectives, description of equipment set-up, laboratory procedures, and questions are also provided. Topics cover homeostasis, phychological stress, biofeedback, weather, flicker fusion rates, chemical reaction rates, cooling curves, heats of neutralization, electrochemistry, and ion measurements. Other important features of HRM software is that the user can write additional programs in BASIC, and printout of graphs is easily obtained.

The innovative science teacher should find many uses for interface devices in their classrooms. Data collection and data calculation are made much faster and more accurate by using the computer as a laboratory instrument. Students receive immediate feedback as the data that they collect are plotted on the computer graph over time. In this way students should gain a greater sense for change, variable control, the meaning of graphs, and relationships among variables. Students' predictions about a system should become more accurate. Ultimately, the advantages of employing hands-on computerized data collection and experimentation should help students acquire greater understanding of the scientific phenomena studied than could otherwise be achieved.

Scientific Methods/Measures

The 1986-87 edition of The Educational Software Selector (TESS) by EPIE Institute lists 27 pieces of software (for the Apple II series) under this heading. Some such as "Discovery Lab" by Sunburst ($59.00, grades 6-9) and "Scientific Methods" by Scott Foresman ($59.95, grades 11-14) are designed to help students gain a better understanding of the so-called "scientific method." Others such as "The Volume Tutor" by Datatech Software Systems ($32.50, grades 8-14) and "Vernier Scales" by Merlan ($35.00, grades 7-14) illustrate specific measurement techniques. All of these skills are much better taught by having students do real labs. As review devices, these scientific methods/measures software might be worth the cost.

Logic/Problem Solving

Some of the most creative computer software falls into this category. Most are in the form of games and Sunburst and The Learning Company seem to be the acknowledged leaders here. A few such as "Incredible Laboratory" by Sunburst ($59.00, grades 3-12) and "Cases 2" by COMPress ($60.00, grades 9-15) use some science-like words and objects, but most are difficult to associate specifically with science content; math teachers could just as easily use them. "Rocky's Boots" ($49.95, grades 2-12) and "Robot Odyssey" ($49.95, grades 9-15) both by The Learning Company have received a great deal of attention from the computer education community. Principles of computer logic, circuit design, and programming are presented in game/simulation format. The graphics and technical quality are excellent! There would be little difficulty in relating these software packages to the study of electronics. "The Pond" by Sunburst ($59.00, grades 2-12), "Logic and Deduction" by Educational Micro Systems ($29.95, grades 4-12), "The Factory" by Sunburst ($59.00, grades 4-12), and "Baffles" by Conduit ($50.00, grades 9-14) are other examples of logic-based games that have received many positive reviews and widespread use.

Graphers/Plotters

It was mentioned in the chemistry section that Project SERAPHIM Series 100, "Methods of Chemistry," had some programs that could be used as data graphers. Also in the chemistry section the Program 7 review of "General Data Analysis Routine" by COMPress ($43.00, grades 10-16) described a versatile, inexpensive software tool that could be very useful in science classes. "Graphical Analysis II" by Vernier ($24.95, grades 9-16) may be the best bargain among the various software tools that accept, analyze, and graph data. "Data Analysis" by EduTech ($34.95, grades 7-16) is also a nice software tool at a very reasonable price.

After using one of these software tools to help in the analysis of data collected in the lab, you will wonder how you ever managed to do things before getting the program. Be sure the software you select is compatible with your printer.

SOFTWARE PUBLISHERS/DISTRIBUTORS

There are two ways to purchase instructional software: (1) buy directly from the publisher and (2) buy from a distribution "house" or supplier. There are a number of advantages of dealing with a distributor who can supply all of your science software. The SAMS Lab has found the main advantage to be that dealing with only one company is far simpler. They get to know you and vice-versa. The SAMS Lab has used Florida Micro Media (P.O. Box 10254, Fort Lauderdale, FL 33305) as its main supplier since 1984. Their prices are competitive, service is good, and they are a Florida-based company.

The Cambridge Development Laboratory (1696 Massachusetts Avenue, Cambridge, Massachusetts 02138) specializes in science software and they have a good national reputation.

Schools usually receive discounts and for larger orders, there are usually larger discounts. Shop around! Be sure to ask whether you can return software that you are not satisfied with. Also, ask about "back-up" disks; some publishers include one back-up with the package while others allow you to make one copy for back-up purposes. A few, like Vernier, allow you to make multiple copies for your class or school.

Publisher Information

This listing covers the companies that were identified as abbreviations in Tables 1, 2, and 3 or that were otherwise identified in this handbook.

1. Brainbank, Inc. (BBX)
   220 Fifth Avenue, New York, NY 10001

2. Broderbund Software (BRODER)
   17 Paul Drive, San Rafael, CA 94903

3. Cambridge Development Laboratory (CDL)
   1696 Massachusetts Avenue, Cambridge, MA 02138

4. COMPress (COMP)
   P.O. Box 102, Wentworth, NH 03282

5. Compuware (COMPUW)
   15 Center Road, Randolph, NJ 07869

6. CONDUIT (CON)
   University of Iowa, Oakdale Campus, Iowa City, IA 52242

7. Cross Educational Software (CROSS)
   P.O. Box 1536, Ruston, LA 71270

8. Datatech Software Systems (DATATE)
   19312 East Eldorado Drive, Aurora, CO 80013

9. Diversified Educational Enterprises (DEE)
   725 Main Street, Lafayette, IN 47901

10. Educational Activities Incorporated (EAC)
P.O. Box 392, Freeport, NY 11520

11. Educational Material and Equipment (EME)
P.O. Box 17, Pelham, NY 10803

12. Educational Micro Systems (EMS)
P.O. Box 471, Chester, NJ 07930

13. EduTech, Inc. (EDUTEC)
303 Lamantine Street, Jamaica Plan, MA 02130

14. Florida Micro Media (FMM)
P.O. Box 10254, Fort Lauderdale, FL 33305

15. Focus Media, Inc. (FOCUS)
839 Stewart Avenue, P.O. Box 865, Garden City, NY 11530

16. High Technology Software Productions (HITECH)
8200 North Classen Blvd., Suite 104, Oklahoma city, OK 73114

17. HRM Software (HRM)
175 Tompkins Avenue, Pleasantville, NY 10570

18. J & S Software (J&S)
14 Vandervente Avenue, Port Washington, NY 11050

19. The Learning Company (LCO)
545 Middlefield Road, Suite 170, Menlo Park, CA 94025

20. Lightspeed Software (LIGHTS)
2124 Kittredge Street, Suite 185, Berkeley, Ca 94704

21. MECC (MECC)
3490 Lexington Avenue North, St. Paul, MN 55126

22. Merlan Scientific, Ltd. (MERLAN)
247 Armstrong Avenue, Georgetown, Ontario L7G46 CANADA

23. Microcomputer Workshops Courseware (MWC)
225 Westchester Avenue, Port Chester, NY 10573

24. Microphys Programs, Inc. (MICRPH)
1737 W. 2nd Street, Brooklyn, NY 11223

25. Programs for Learning (PFL)
P.O. Box 1199, New Milford, CT 06776

26. Scholastic, Inc. (SCHOLA)
730 Broadway, New York, NY 10003

27. Scott, Foresman & Company (SCOTT)
1900 East Lake Avenue, Glenview, IL 60025

28. SERAPHIM (SERAPH)
Eastern Michigan U., Chemistry Dept., Ypsilanti, MI 48197

29. Sunburst Communications, Inc. (SUNB)
39 Washington Avenue, Room EA, Pleasantville, NY 10570

30. Ventura Educational Systems (VENTUR)
3440 Brokenhill Street, Newbury Park, CA 91320

31. Vernier Software (VERN)
2920 S.W. 89th, Portland, OR 97225

FINAL THOUGHTS

A recent (May 1986) paper in the Educational Researcher by M. Lockheed and E. Mandinach presents a rationale for changing the focus on computer literacy/education. They noted that most computer literacy programs emphasize information about the computer and programming (usually BASIC). They also said that there was evidence that many of these courses seemed to reduce students' interest in computers. Integrating computers into the regular curriculum was proposed by these authors as a more sensible, effective way to help students understand the value of computers. The SAMS Lab is solidly in support of this position. Computers must be integrated into the regular curriculum if we are to realize their potential.

Principals and others in a position to make these decision, must realize that the real potential of computers lies in their ability to improve the learning of science, mathematics, and other content areas. The computer is a very special tool that, when used properly, can provide learning opportunities for students that otherwise would be unavailable. Computers should be located in science classrooms (and other classrooms) so students and teachers can use good software in biology, chemistry, physics, etc., to make learning more interesting and more effective. Lab interface devices, interactive simulations of complex systems, graphers/plotters, and other computational tools are available now. What is needed is to get computers into the classrooms!

In the future, we might have intelligent computer tutors that can diagnose and instruct students as human teachers do now. As artificial intelligence techniques are refined and applied to education, intelligent computer-assisted instruction (ICAI) will become a reality. We do not have to wait until then, however, to make good use of the relatively simple hardware and software that is now widely available. The SAMS Lab at Florida State University conducts workshops and provides other assistance to help science teachers, principals, and others to better utilize computers in education.